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Natural Resources
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Pat Quinn, Governor
Marc Miller, Director

August 31, 2012

Mr. Mike Fausz, Zoning Administrator
Monroe County Zoning Department
100 South Main Street
Waterloo, IL 62298

RE: Admiral Parkway Wind Farm, Valmeyer, Monroe County
Endangered Species Consultation Program
Natural Heritage Database EcoCAT Review #1112849

Dear Mr. Fausz:

The Department of Natural Resources has reviewed this project in Monroe County for the purpose of consultation between the Department and Monroe County pursuant to the *Illinois Endangered Species Protection Act* [520 ILCS 10/11], the *Illinois Natural Areas Preservation Act* [525 ILCS 30/17], and Title 17 *Illinois Administrative Code* Part 1075.

Over the past ten years, the Department has evaluated scores of wind energy projects, ranging from solitary wind turbines to arrays of hundreds, for their potential adverse effects on the natural resources protected by these statutes. No other wind energy project proposed thus far in Illinois faces the severity of natural resource challenges presented by the Admiral Parkway Wind Farm proposal. Often such hurdles can be overcome through allocating more funding to research, to the implementation of avoidance and minimization measures, and to mitigation for unavoidable harms. In this instance it is possible, even likely, that no amount of additional expenditure can avoid, minimize, or mitigate for the adverse effects which may result from implementation of this project. It is the Department's belief this vicinity is ecologically unsuitable for the deployment of wind energy generation technology.

It is helpful to refer to the *Land-Based Wind Energy Guidelines* published by the U. S. Fish & Wildlife Service on March 23, 2012, which presents a five-tiered process for assessment of fish & wildlife impacts of wind energy development. Each Tier is intended to provide criteria for a decision whether to abandon a proposal or proceed to the next Tier of assessment. The Department believes that application of the *Guidelines* to this project would dictate an abandonment determination as early as Tier One.

It is the biological opinion of the Department this project should be the subject of a formal consultation with the United States Fish & Wildlife Service on the potential for incidental takings of the **Bald Eagle**, *Haliaeetus leucocephalus*, and the **Golden Eagle**, *Aquila chrysaetos*.

It is the biological opinion of the Department the proposed action is likely to adversely modify the essential habitats of the state-listed (and federally-listed) endangered **Illinois Cave Amphipod**, *Gammarus acherondytes*; the **Indiana Bat**, *Myotis sodalis*; and the **Gray Bat**, *Myotis grisescens*.

It is the biological opinion of the Department the proposed action is likely to adversely modify the essential habitats of the state-listed endangered **Common Striped Scorpion**, *Centruroides vittatus*; the **Madonna Cave Springtail**, *Pygmarrhopalites madonnensis*; and the state-listed threatened **Eastern Narrowmouth Toad**, *Gastrophryne carolinensis.*

It is the biological opinion of the Department the proposed action is likely to adversely modify the essential habitats of the state-listed endangered **Coachwhip Snake**, *Masticophis flagellum*; and the **Great Plains Rat Snake**, *Pantherophis emoryi*; as well as the state-listed threatened **Flathead Snake**, *Tantilla gracilis*; and the **Timber Rattlesnake**, *Crotalus horridus*.

It is the biological opinion of the Department the proposed action is likely to adversely modify the essential habitats of the state-listed endangered **Loggerhead Shrike**, *Lanius ludovicianus*; and the state-listed threatened **Mississippi Kite**, *Ictinia mississippiensis*; the **Black-Billed Cuckoo**, *Coccyzus erythropthalmus*; and the **Cerulean Warbler**, *Dendroica cerulea,* in addition to posing a significant threat to hundreds of species of other migratory birds during annual movements.

The Department recommends the applicant seek from the Department an Incidental Take Authorization, pursuant to Section 5.5 of the *Illinois Endangered Species Protection Act*, for each animal listed above, with the exceptions of the Bald Eagle and Golden Eagle, for which incidental taking jurisdiction rests solely with the federal government.

It is the biological opinion of the Department the proposed action is likely to adversely modify the essential habitats of numerous state-listed plants: the endangered **Crested Coralroot Orchid**, *Hexalectris spicata*; the **Dwarf Bedstraw**, *Galium virgatum*; the **Fameflower**, *Talinum calycinum*; the **Shortleaf Pine**, *Pinus echinata*; the **Slender Heliotrope**, *Heliotropium tenellum*; the **Spurge,** *Euphorbia spathulata*; **Whitlow Grass**, *Draba cuneifolia*; **Black-Edged Sedge**, *Carex nigromarginata;* and the **Woolly Buckthorn,** *Bumelia lanuginosa*; as well as the threatened **Missouri Orange Coneflower**, *Rudbeckia missouriensis*.

It is the biological opinion of the Department the proposed action is likely to adversely modify environmental conditions within the **Salt Lick Point Land and Water Reserve** and the associated **Columbia Hill Prairie Illinois Natural Areas Inventory (INAI) Site**.

It is the biological opinion of the Department the proposed action is likely to adversely modify environmental conditions within the **White Rock Land & Water Reserve**, the **Martha and Michelle Prairies Land & Water Reserve**, the **Luella Schaefer Memorial Land & Water Reserve**, the **Snakey Acres Natural Heritage Landmark**, the **Potato Hill Natural Heritage Landmark**, as well as the **Potato Hill Prairie INAI Site** which underlies or surrounds each of these.

It is the biological opinion of the Department the proposed action is likely to adversely modify environmental conditions within the **Frog Karst System INAI Site**, the **Pautler-Annbriar Karst System INAI Site**, the **Madonnaville Cave INAI Site**, and the associated **Pautler Class 3 Ground Water Area**.

The consultation provisions of the statutes cited above require units of local government to evaluate whether the actions they may authorize might adversely affect or modify these natural resources. The provisions of the *Illinois Natural Areas Preservation Act* require the Department to render recommendations for measures to avoid, minimize, or mitigate for adverse effects and modifications, and for the County to attempt to avoid or mitigate for adverse effects consistent with the proposed action.[1] In some circumstances, no such recommendations may be possible. No recommendations made by the Department should be construed to imply the Department's approval or endorsement of the proposed action. Itemized discussions of the issues follow.

Bald Eagle, *Haliaeetus leucocephalus*; Golden Eagle, *Aquila chrysaetos*. Though no longer listed as endangered or threatened by the state or federal governments, the Bald Eagle and the Golden Eagle remain protected under the federal *Bald and Golden Eagle Protection* Act [16 U.S.C. 668-668d].

Wind turbine siting guidelines drafted by the U.S. Fish & Wildlife Service call for consultation with the Service whenever a wind turbine may be located within ten miles of "an important Eagle activity area." Migratory pathways, foraging areas, night roosts, and nests fall in this category. It is now, hypothetically, possible to acquire Take Permits for Eagles under federal regulations; however, to the Department's knowledge, three years after institution of the Rules, the Service has yet to issue such a permit anywhere in the contiguous forty-eight States.

Golden Eagles do not breed in Illinois, and so are not tracked by the Department, which records only the locations of nesting attempts by protected species. However, Illinois is within the winter range of the Golden Eagle, and observers have reported this species south of St. Louis in recent winters. In its preamble to the current federal regulations for Eagle Take [50 CFR 22.26], the Service stated its intention to issue no Take Permits for the Golden Eagle east of the 100th Meridian, with the exception of safety emergencies. All of Illinois and Missouri fall within this exclusion. The vulnerability of the Golden Eagle to wind turbine collisions is well-documented. Thus, the presence, although temporary and transient, of Golden Eagles in the vicinity poses a serious risk to a wind farm in Monroe County for which no relief through a permit may be granted.

Bald Eagle nests are present along the Mississippi River within ten miles of the proposed wind farm, and both resident and migrant Bald Eagles pass directly over the project area on a frequent basis. Winter night roosts may exist in the bluff-line forests. In contrast to the Golden Eagle, only five Bald Eagles have been documented to be killed or injured by wind turbines in the U.S. and Canada. However, the avoidable loss of Bald Eagles can result in severe penalties and will disqualify the offender from ever qualifying for a subsequent Take Permit. Hence the routine presence of the Bald Eagle in the vicinity of the wind farm poses a significant risk.

[1] 525 ILCS 30/17

Recommendation #1: The Department recommends the County consider imposing a requirement the applicant must supply the County with documentation that a formal consultation with the U.S. Fish & Wildlife Service regarding the Eagles has occurred.

Migratory Birds. More than 400 species of birds protected under the federal *Migratory Bird Treaty Act* [16 U.S.C. 703] are known to migrate through or breed in Monroe County. The Mississippi River marks the middle of the North American Central Flyway, and millions of birds travel north and south along the general path of the River. No fewer than 23 of the 30 species of migratory birds listed as endangered or threatened in Illinois have been observed along the Bluff Corridor and the Bottomlands of Monroe County. The proximity of the wind farm to this corridor increases the risk of taking listed species which do not breed in Monroe County.

Experience in the wind energy industry has shown the great majority of birds killed by wind turbine collisions are nocturnal migrating song-birds (passerines). Losses are much higher on overcast nights with low cloud ceilings and foul weather, which apparently induce flocks to fly at lower altitudes than usual; mass kills have occurred at wind farms where white lights are left on inside nacelles or at interconnection substations. In Illinois, average avian losses have been reported in the range of two-to-six birds per turbine per year, but none of the 23 existing Illinois wind farms lies in a major migratory corridor, as would be the case here.

The applicant has performed the daytime avian use surveys within the project area which have become standard in the wind energy industry. While these are useful for tallying the numbers and diversity of birds using the habitat in the daytime, they are unable to reveal the numbers and species passing overhead at night or resting in nearby forests during the day. One method of addressing this shortcoming is the night-time use of audio recordings of passing flocks, which permits ornithologists to identify species by their calls and to estimate their numbers. Another alternative is the use of small marine radars to identify the size, course, and altitude of migrating flocks.

Many nocturnal migrants seek daytime rest (staging) in riparian and upland forests. Monroe County lies inside an westward bend in the Mississippi River's course, so that birds flying along the general line of the River will fly directly over or through the proposed wind farm location. The western flank of the proposed wind farm is bordered by extensive bluff-line forests which provide key resting and staging habitat for migratory birds, with birds descending in the mornings and ascending in the evenings. These factors suggest the proposed wind farm will be at high-risk of taking elevated numbers of migratory birds as they arrive and depart. It might be thought that increasing the project's distance from the River would decrease the risk of avian mortality, but no studies exist which establish that the numbers of migrants actually decrease with distance from the River.

Among the non-listed migratory birds breeding in the bluff forests of Monroe County is the **Whip-Poor-Will**, *Caprimulgus vociferus*. Illinois populations of this species are in serious decline and the bluff forests near Valmeyer are among the few areas remaining in the State where the song of this ground nester is frequently heard. Noise and vibration from the wind farm could disrupt the nesting behavior of this species, and pose direct hazards to foraging adults.

The most obvious action which could be taken to reduce or avoid avian mortality, in the proposed location, would be the curtailment of night operations during the spring and fall migration periods. Such action would seriously impair the project's economic feasibility.

Recommendation #2: The County should consider a requirement the applicant perform night-time acoustic and/or radar recordings during spring and fall migrations to quantify the numbers of migratory birds passing through the proposed project area for at least one spring and fall season before and after construction.

Recommendation #3: The County should consider a requirement the applicant perform post-construction monitoring of avian mortality at each proposed wind turbine to quantify avian losses due to the project for at least one spring and fall season.

Recommendation #4: Should the post-construction avian mortality monitoring reveal instances of elevated avian mortality associated with migratory movements, the County should consider a requirement to curtail nighttime operations during the spring and fall migratory seasons.

Illinois Cave Amphipod, ***Gammarus acherondytes*****.** The Illinois Cave Amphipod is listed as "endangered" by both the State of Illinois and the federal government. This small crustacean is found only in caves, and only in the caves located within the karst geology of St. Clair and Monroe Counties, Illinois. It is known from nowhere else in the world.

It is an obligate cave-dweller. Much of its habitat is completely inaccessible to human beings, and thus its numbers and ecology are poorly understood. In the past, concerns about adverse human influences on this species have centered on the pollution of ground waters entering the cave systems in which it lives. However, the construction of utility-scale wind turbines above and adjacent to its essential habitat poses new potential threats.

Alteration of ground water quality and quantity potentially threaten this species. The installation of turbine service roads and power collection cables may alter or block the path of surface drainage, and thus affect the points and rates at which surface waters infiltrate the karst system. Such changes may accelerate or retard the development of underground voids. It is difficult to say whether such changes would be detrimental or beneficial to the Illinois Cave Amphipod over the long term, but sudden changes in the short-term patterns of infiltration are likely to be adverse.

As the County is well-aware, karst geology is fundamentally unstable. Utility-scale wind turbines, weighing hundreds of tons, require substantial foundations to withstand the variable stresses imposed on the tower by wind forces from all directions. Standard foundations are likely inappropriate in this geological context; the risk of sinkhole development likely requires more robust foundations than usual. Excavation above or into bedrock in a karst area carries an inherent risk of altering existing underground openings which may contain Illinois Cave Amphipods or which support their habitat needs. This risk would be exacerbated if blasting were necessary. (Past blasting associated with limestone mining occurred at greater distances from caverns than would be true of wind farm construction.)

Operation of a wind turbine results in periodic vibrations which pass through the tower into the surrounding substrates; even when turbines do not operate, vibrations are created and transmitted as towers "thrum" in the wind. The energy in vibrations can weaken receiving materials. The vibrations which result from the operation of a turbine can produce forces with the potential to alter ground water flow and quality, and even the physical configuration of subterranean voids. In turn these could alter the flow-paths of underground waters.

Studies in Scotland have shown that medium-sized wind turbines, smaller than those proposed, produce micro-seismic vibrations which can be detected six-miles away.[2] The Department is not aware of any seismic studies performed in North America related to wind farm operations. But from the studies in the United Kingdom it is clear that wind turbines in the vicinity of an important karst feature may have adverse consequences even though they are not located directly above it. All portions of the proposed project area are less than three miles from delineated karst features believed to be occupied by the Illinois Cave Amphipod, and thus may be prone to experience acoustic, hydrologic, or geophysical disturbances related to turbine construction and operation.

The potential impacts of acoustic energy radiating from a wind turbine will be closely related to subsurface morphology of the land beneath and around the individual turbine, but the construction of a wind *farm* compounds the potential for adverse impact, since *multiple* acoustic sources will exist. At some points colliding vibrations will be amplified and at others they will be dampened. Moreover, the frequency and amplitude from each machine will vary with wind speed and direction, confounding efforts to model or assess potential consequences.

The structure of intervening strata and the shapes of subterranean voids may also modify the expression of acoustic energy passing through them. In addition, discussions with scientists researching the Illinois Cave Amphipod indicate laboratory specimens exhibit strong reactions to accidental acoustic stimulation, such as when an aquarium is bumped by a researcher or piece of equipment.[3] While no experimentation with acoustic stimuli has been approved, these observations suggest this species would be highly responsive to the transmission of sounds through bedrock. Sustained agitation during prolonged wind energy generation could render habitat untenable, and even result in the exhaustion and death of individual amphipods.

A great deal remains to be learned about these animals and their environment before new human sources of impact can be safely planned.

As required by the provisions of the *Illinois Natural Areas Preservation Act* the following recommendations are believed to be consistent with the planned action. However, the Department suggests it would be simpler to locate the wind farm development in areas distant from karst geology and the Illinois Cave Amphipod.

[2] Styles, et al.; Microseismic and Infrasound Monitoring of Low Frequency Noise and Vibrations from Windfarms; Keele University; Staffordshire, UK; July 2005.
[3] Shank, Keith M.; Personal communication with Dr. Frank Wilhelm, University of Idaho, November 1, 2011.

Recommendation #5: The Department recommends the County consider a requirement for the applicant to seek an Incidental Take Authorization from the Department of Natural Resources for the Illinois Cave Amphipod.

Recommendation #6: The Department recommends the County consider a requirement for detailed mapping of subterranean voids and passages, sinkholes, and sinkhole areas prior to authorizing any construction related to the proposed wind farm. However, the applicant should be aware that even advanced technologies appropriate for use in such mapping may have potential adverse effects on the Illinois Cave Amphipod which would require specific authorization from the Department of Natural Resources and the U.S. Fish & Wildlife Service.

Recommendation #7: The Department recommends the County consider a prohibition of blasting for purposes of establishing adequate foundations.

Recommendation #8: The Department recommends the County consider a requirement the applicant provide or acquire information pertaining to the generation and propagation of acoustic energy into the ground by the selected turbine model. The applicant should be aware that acoustic signatures may vary enough to allow identification of individual machines in an array, similar to the way in which individual naval vessels can be identified by the acoustic signatures of their power plants, even among ships of the same class. This will be even truer among turbine models and manufacturers—data applicable to one model will not be transferable to another.

Recommendation #9: Consistent with the laws governing endangered species, the Department recommends the County consider a requirement the developer determine the sensitivity of the Illinois Cave Amphipod to anthropogenic noise, particularly at the frequencies and intensities to be expected from the selected model of wind turbine.

Recommendation #10: The Department recommends the County consider a requirement the applicant minimize any alteration of surface or subsurface hydrology by carefully mapping pre-construction surface drainage and adopting measures to assure that the path and flow rates of such drainage are maintained during and after construction, including expeditious repair or replacement of any drain tiles which may be present.

Recommendation #11: The Department recommends the County consider a requirement the applicant provide training to all workers employed on the project describing the sensitivity of the Illinois Cave Amphipod and the importance of careful management of fuels, lubricants, portable toilets, and other potential ground water pollutants.

Indiana Bat, *Myotis sodalis*. The Indiana Bat is listed as "endangered" by both the State of Illinois and the federal government. During a July 2011 mist-netting survey conducted on behalf of the applicant, a male Indiana Bat was captured along the western edge of the proposed project area. This animal was fitted with a transmitter, but surveyors were unable to track the animal to a day roost, either because the bat immediately left the area or because the transmitter failed.

The Indiana Bat is known to use Illinois Caverns, about seven miles southeast of the project area, as a winter hibernaculum. However, not all caves used in this way are known and hundreds of caves exist in Monroe County. Male Indiana Bats also shelter in Illinois Caverns during the summer, although most Indiana Bats roost in trees when not hibernating (illustrating that there are always exceptions to the rule). Indiana Bats are migratory, ranging as far as 300 miles from their winter cave, although many travel much lesser distances. Caves must satisfy strict criteria of temperature and humidity in order to provide winter habitat for this species. Cave temperature and humidity may be altered by any changes in the size and shape of cave openings or changes to their hydrology.

The Indiana Bat is known to be vulnerable to wind turbine collisions, especially during fall migration. The position of the proposed wind farm relative to maternity colonies and hibernaculae is unknown, rendering an assessment of collision risk difficult. The Fowler Ridge Wind Farm in Benton County, Indiana, documented Indiana Bat kills in consecutive years (September 11, 2009, and September 18, 2010), which is suggestive the wind farm was inadvertently placed on a migratory route for this species. Netting and other surveys in the spring and summer provide useful information, but provide little insight into migratory patterns or destination winter caves.

The species is also highly vulnerable to a recently-identified disease, White Nose Syndrome, associated with a newly-described fungus, *Geomyces destructans,* which thrives in cave environments. Though not yet identified in an Illinois cave, this fungus has been reported from Indiana, Kentucky, Missouri, and Iowa. There is a strong possibility Indiana Bats using Monroe County over-winter in Missouri, and thus may carry the infection.

Because Indiana Bats are not solitary animals, the bat captured in July 2011 may have been associated with a bachelor colony in the immediate vicinity, or it may represent an early migrant. The presence of extensive bluff-line forests suggests that, had netting extended well beyond the project area, more Indiana Bats may have been captured.

At present, the U. S. Fish & Wildlife Service is recommending operational curtailment of wind turbines from August 1 to September 30 whenever wind speeds fall below 6.9 meters per second (15.4 mph) to reduce the risk of taking an Indiana Bat. This recommendation, if implemented, will certainly reduce the productivity (and economic value) of this project. Because curtailment cannot guarantee a listed bat will not be taken (only full cessation of night operations can do so), it will be prudent for the owners of the project to seek Incidental Take Authorization from both the federal and state governments, a costly undertaking whose outcome is uncertain and may be unfavorable.

Recommendation #12: The Department recommends the County consider imposing a requirement for the applicant to seek an Incidental Take Authorization from both state and federal agencies for the Indiana Bat.

Recommendation #13: The Department recommends the County consider requiring the applicant to conduct additional mist-netting, telemetry, and acoustic surveys, including areas within 2.5 miles of project boundaries, to better identify the scale of Indiana Bat occupancy and

activity in the vicinity. All approved protocols to prevent the spread of White Nose Syndrome should be employed when handling bats to prevent the spread of this disease.

Recommendation #14: The Department recommends the County consider requiring the applicant to develop and implement a bat monitoring and protection plan to reduce the risk of taking the Indiana Bat.

Gray Bat, *Myotis grisescens*. The Gray Bat is listed as "endangered" by both the State of Illinois and the federal government. Acoustic monitoring during 2011 recorded the distinctive calls of the Gray Bat several times on several dates near Valmeyer, but no Gray Bats were captured during mist-netting, so no telemetry was attempted.

The Gray Bat is a true "cave bat," roosting in caves during both winter and summer. (It is also migratory, and does not breed in the same caves in which it hibernates.) Consequently, the Gray Bat must forage in areas near the caves it occupies. The Gray Bat is known to roost in Illinois Caverns, about seven miles southeast of the project area, but may use other caves and mines in the vicinity. Importantly, reproductive females do not share caves with males, non-reproductive females, and juveniles. Thus, the presence of a population implies that several caves which provide suitable habitats for this species exist in the near vicinity. Gray Bats generally forage over water bodies and in woodlands.

As with the Indiana Bats, caves suitable for occupancy by the Gray Bat exhibit specific temperature and humidity ranges; it has been estimated that only 5% of available caves are used by this species. Anything that alters the cave's attributes may render it unsuitable as habitat for this species.

Because the Gray Bat spends much of its life in caves, it is expected to be vulnerable to White Nose Syndrome.

The Gray Bat may be as vulnerable to wind turbine collisions as are other bat species, but few wind turbines have been erected within the range of this species, and a fatality resulting from turbine collision has yet to be reported.

Recommendation #15: The Department recommends the County consider imposing a requirement for the applicant to seek an Incidental Take Authorization from both state and federal agencies for the Gray Bat.

Recommendation #16: The Department recommends the County consider requiring the applicant to conduct additional mist-netting, telemetry, and acoustic surveys, including areas within 2.5 miles of project boundaries, to better identify the scale of Gray Bat occupancy and activity in the vicinity, including the locations of roosting caves.

Recommendation #17: The Department recommends the County consider requiring the applicant to develop and implement a bat monitoring and protection plan to reduce the risk of taking the Gray Bat.

Common Striped Scorpion, *Centruroides vittatus*. This species is currently known in Illinois only from portions of Monroe and Randolph Counties. As its name implies, this scorpion is the most common and widespread in North America, but it is at the extreme northeastern part of its range in Illinois; hence its listing. It is the most common scorpion in Texas, which also has a great many utility-scale wind turbines. However, it appears that scorpions are so common there (even regarded as pests) that nobody has studied their interactions with utility-scale wind turbines.

A short and limited survey of Bluff Road talus slopes[4] confirmed the presence of this species in Monroe County. This might suggest to some that *C. vittatus* is limited to such habitats in Illinois, but in more central parts of its range it occupies a wide range of habitats and Illinois data are too sparse to warrant a conclusion this animal is not more widely distributed. In fact, the central question for this project, regarding the Scorpion, is how widely dispersed this species may be within and near the project area. Anecdotal information suggests this species may occur several miles inland from the bluff talus slope areas.

Adults of this scorpion average a bit more than two inches in total length. Like most scorpions, it is most active in darkness, spending the day under cover beneath bark, rocks, and vegetative litter. Even moonlight can reduce this animal's activity. Like other scorpions, this species fluoresces in ultra-violet light; hand-held battery-operated black lights are among the most effective survey tools.

Apart from direct injury or death during construction, the operation of utility-scale wind turbines may adversely affect scorpions in several ways.

Scorpions strongly prefer the dark, both for thermo-regulation and concealment from both prey and predators. In addition to their multiple eyes, their integuments (shells) also contain photo-sensors that are extremely sensitive to ultra-violet radiation. Intermittent illumination from multiple sources at night (flashing red strobes on nacelles, lunar "flicker" caused by rotor movement) may limit the extent of the "landscape" in which scorpions can be active.

The Common Striped Scorpion does not burrow; it strikes from ambush or actively hunts, using organs called "pectins" which are sensitive to both mechanical and chemical stimuli. As a scorpion moves, it periodically places its pectins in contact with the ground or other surface to detect chemical scent trails or minute vibrations. While wind turbines are unlikely to alter or modify chemical scents, the mechanical stimulation produced from ground vibrations could be problematic. Scorpions do not need to eat frequently and can spend long periods in a state of inactivity and lowered metabolism, but this state may be difficult to achieve or maintain in the face of constant stimulation. Vibration may also simulate the approach of predators, which may stress the scorpions, conceal the approach of actual predators, or interfere with their complex and time-consuming mating dance. Vibrations could also adversely modify talus-slope habitat by gradually filling or reducing the voids where scorpions find both food and safety.

[4] Anton, Thomas G.; Current Distribution of the Common Striped Scorpion (*Centruroides vittatus*) in Illinois; Unpublished Report; Illinois Department of Natural Resources; Springfield, IL; 1996.

Wind turbines may influence the abundance of prey or predators in areas where scorpions are normally active. These influences could be positive or negative.

Recommendation #18: The Department recommends the County consider a requirement for sufficient surveys for the Common Striped Scorpion throughout the project area and the adjacent vicinity to delineate the areal extent of occupation and estimate its numbers.

Recommendation #19: The Department recommends the County consider imposing a requirement for the applicant to seek an Incidental Take Authorization from the Department for the Common Striped Scorpion; this species is known to occupy habitat close enough to the project to be affected.

Recommendation #20: The Department recommends the County consider a requirement for laboratory studies of Common Striped Scorpion behavior in response to intermittent illumination similar to that received from a wind farm and in response to vibrations typical of a wind farm.

Recommendation #21: The Department recommends the County consider a requirement the applicant provide training to all workers employed on the project regarding the Common Striped Scorpion and the procedures to be followed in response to sightings or encounters with this species.

Madonna Cave Springtail, *Pygmarrhopalites madonnensis*. The Madonna Cave Springtail is an animal belonging to the Order *Collembola* (Springtails), of the sub-phylum *Hexapoda*, a division of the Arthropods. Only recently described to science, the Madonna Cave Springtail is known from only one location in the world, the Madonnaville Cave in Monroe County, a location it shares with the **Illinois Cave Amphipod**.

Small six-legged creatures, Springtails are so-called because their tails are tipped with specialized scales which can be "cocked." These animals do not fly or jump. When a springtail is disturbed or threatened, the tension in these scales is suddenly released, which propels the entire animal several feet through the air, like a giant spring.

Collembola is a large Order, containing hundreds, if not thousands, of undescribed species. Most are detritivores, feeding on decaying plant and animal materials and recycling nutrients into the ecosystem. Springtails are commonly collected in traps baited with Limburger Cheese, suggesting that chemical cues are an important factor in their ability to locate food. Many springtails appear to be specifically evolved to live in the environment in which they are found, and have a very limited ability to relocate to avoid adverse effects. Those which live in caves appear to be adapted to the cave mouth, which is often relatively well-lit, or to the deep cave environment where no light ever penetrates, or to the "twilight" area between.

After an extensive survey of caves and sinkholes in Monroe and Randolph Counties,[5] the Madonna Cave Springtail appears to be unique to the Madonnaville Cave System, part of which

[5] Soto-Adames, Felipe N., and Taylor, Steven J.; Status Assessment Survey for Springtails (*Collembola*) in Illinois Caves: The Salem Plateau; Illinois Natural History Survey Technical Report 2010(13); Champaign, IL; March 30, 2010.

underlies the project area, with the remainder lying within a few miles of it. Its abundance in the cave is unknown, and its habitat requirements and ecology are poorly understood. Consequently, protective recommendations are conservative.

The movement of organic detritus through the Madonnaville Cave system is of crucial importance. If food becomes too scarce in the cave zones this species can occupy, the population may crash. If food becomes too abundant, the species may be displaced by others that can out-compete it. Conversely, if the balance is upset, the Madonnaville Cave Springtail could out-compete and displace other springtails and arthropods which share its ecosystem, with unforeseen consequences to cave ecology. Preventing alteration of the cave's hydrology and atmosphere are crucial.

The Madonna Cave Springtail has its own predators, which it is equipped to avoid. Any stimulus which mimics the approach of a predator will evoke an evasion response—deployment of the spring-tail. Such a stimulus constantly applied may exhaust individuals to the point they become easy prey for others.

As with other arthropods, chemical scents are important, but so are vibrations, which can indicate the location of prey or the approach of predators. Apart from the potential alteration of the physical cave system during construction, the constant vibrations emanating from operating turbines may pose the most inimical influence on this species, producing a very high-stress environment, which the Springtails cannot escape.

Given its very limited distribution, resource-poor habitat, and probably small population, the risk of extirpating this species through relatively minor habitat alterations may be high.

Recommendation #22: The Department recommends the County consider imposing a requirement for the applicant to seek an Incidental Take Authorization from the Department for the Madonna Cave Springtail.

Recommendation #23: The Department recommends the County consider a prohibition of blasting for purposes of establishing adequate foundations.

Recommendation #24: The Department recommends the County consider a requirement the applicant undertake or financially support scientific laboratory studies of the Madonna Cave Springtail's ecology and behavior, with particular investigation of its responses to acoustic stimuli in the ranges produced by operating wind turbines. (Scientific permits from the Department may be required to do so.)

Recommendation #25: The Department recommends the County consider a requirement for detailed mapping of subterranean voids and passages associated with the Madonnaville Cave prior to authorizing any construction related to the proposed wind farm. However, the applicant should be aware that even advanced technologies appropriate for use in such mapping may have potential adverse effects on the Madonna Cave Springtail which would require specific authorization from the Department of Natural Resources.

Recommendation #26: The Department recommends the County consider a requirement the applicant provide or acquire information pertaining to the generation and propagation of acoustic energy into the ground by the selected turbine model. The applicant should be aware that acoustic signatures may vary enough to allow identification of individual machines in an array, similar to the way in which individual naval vessels can be identified by the acoustic signatures of their power plants, even among ships of the same class. This will be even truer among turbine models and manufacturers—data applicable to one model will not be transferable to another.

Recommendation #27: The Department recommends the County consider a requirement the applicant minimize any alteration of surface or subsurface hydrology by carefully mapping pre-construction surface drainage and adopting measures to assure that the path and flow rates of such drainage are maintained during and after construction, including expeditious repair or replacement of any drain tiles which may be present.

Recommendation #28: The Department recommends the County consider a requirement the applicant provide training to all workers employed on the project describing the sensitivity of the Madonna Cave Springtail and the importance of careful management of fuels, lubricants, portable toilets, and other potential ground water pollutants.

Eastern Narrowmouth Toad, *Gastrophryne carolinensis*. This species, actually a small terrestrial frog and not a true toad, is at its northwesternmost range limits in Monroe County. In recent years the species has been most often detected on the talus slopes along the Bluff Road, but it has also been documented from several sites on the karst plateau, where it occupies areas around flooded sinkholes, where it breeds. These known locations occur north, south, and west of the proposed project area, suggesting that similar habitat within the project area may also be occupied by this species.

The Eastern Narrowmouth Toad displays some migratory behavior on a small scale, moving between floodplain and upland habitats on a seasonal basis. Its ability or inclination to disperse from breeding areas is not well-known.

In the Southeastern United States this species is extremely common and is often used for laboratory assays of toxins, particularly for methyl-mercury contamination (a mere one part per billion is fatal to eggs and tadpoles of this species). However, few, if any, wind energy generation projects have been constructed within the range of this species, where it would also be common and of slight concern, so that potentially adverse effects due to wind turbines are unknown.

Like other frogs, it is most active at night; by day it retreats beneath leaf litter, vegetation, or underground—its rear feet possess a "spade" which aids in burrowing. This habit, combined with its small size (<1.5 inches total length), makes it seldom observed by humans, though often heard after dark. Its primary diet consists of ants, although it will also feed on other insects, spiders, arthropods, and snails. Snakes are among its primary predators.

The central question for this project, regarding this species, is whether and to what degree the Eastern Narrowmouth Toad occupies habitats which may be directly or indirectly disturbed by wind farm construction and operation, and whether any such populations are sparse or numerous. Agricultural fields are generally not thought to provide habitat, but this species may move through them on a seasonal basis, and even ephemeral wetlands within a field may offer reproductive habitat.

Because of its burrowing habit, excavation, cable trenching, and road-building have the potential to "take" individual Toads which may be present, while permanent roads may fragment habitat or increase exposure to predators when they must be crossed to reach breeding or hibernation areas. Wind turbine vibrations may have the potential to alter both talus and sinkhole habitats in ways which reduce their value for feeding, reproduction, and hibernation.

Recommendation # 29: The Department recommends the County consider requiring the applicant to perform sufficient biological surveys to estimate the numbers of Eastern Narrowmouth Toads in the vicinity and their locations.

Recommendation #30: The Department recommends the County consider a requirement for periodic monitoring of the levels of elemental mercury and methyl mercury in soils and waters within the project area. Wind turbines will have no effect on mercury levels but are not the only threat to this species in this vicinity. Should the Eastern Narrowmouth Toad decline or disappear from the vicinity of the project and it can be shown that mercury levels have increased, the disappearance of the Toad will not be mistakenly attributed to the wind farm.

Recommendation #31: The Department recommends the County consider imposing a requirement for the applicant to seek an Incidental Take Authorization from the Department for the Eastern Narrowmouth Toad.

Recommendation #32: The Department recommends the County consider a requirement the applicant provide training to all workers employed on the project regarding the Eastern Narrowmouth Toad and the procedures to be followed in response to sightings or encounters with this species.

Coachwhip Snake, *Masticophis flagellum flagellum*. This is another species at the northern extreme of its range in Monroe and Randolph Counties; the seven subspecies of the Coachwhip are quite common across the southern United States and Mexico, including both Texas and California, with their thousands of wind turbines. But their abundance in those locations means that their interactions with wind farms, whether positive or negative, have not been studied.

The Coachwhip is a long thin-bodied snake, often four-to-six feet long, with a record length exceeding eight feet. Its length and color patterns, which can give the appearance of braided leather, are responsible for its common name. This snake is skittish and extremely fast, so that it is rarely seen by humans, even where they are abundant—many Illinois records are based on road-kills.

Its prey are diverse, including insects, frogs and toads, other snakes, birds, and small mammals, up to the size of rabbits for larger specimens. This snake is not venomous, nor is it a constrictor; it seizes prey by the head and swallows it alive and whole. Active during the day, it is fast enough to pursue and capture prey; it hunts by both scent and sight, and can sometimes be observed moving with its head elevated above ground vegetation. It is often active under high-heat conditions which cause other snakes to seek shelter, and its high metabolism means it must feed more often than many other snakes. It will hunt on the ground, in the trees, and under the ground.

Range extension to the north is likely limited by average winter low temperatures and the availability of underground refuges deep enough to provide thermal protection from freezing. If this snake is limited to the hill prairies and bluffs of Monroe and Randolph Counties, it may be because such refuges are more readily available in this region. However, through most of its range it can be found in a wide range of habitats, and this may also be true in Illinois, but its shyness and speed may result in few human observations outside areas where it is expected.

Prey and habitat for the Coachwhip are abundant throughout and adjacent to the project area, but naturalists have applied most of their search efforts to the bluffs and hill prairies to the west. Whether the Coachwhip population makes any use of the woodlands and agricultural fields within, north, east, and south of the project area is unknown. Population numbers of this species are believed to be low, based on the rarity of observations, but actual data are few.

Direct mortality from vehicles and heavy equipment is an obvious threat. Closure of or physical damage to unrecognized but essential winter refugia is another potential threat. Vibration from operating turbines experienced within refugia may interfere with or prevent achieving the state of inactivity needed to survive a winter. Snakes in general rely on detecting vibrations in the ground through their belly scales to determine if predators are nearby and will actually move away from those vibrations to avoid detection. Since the Coachwhips are overwintering in the river bluffs of Monroe and Randolph counties, and need to remain dormant during hibernation (to conserve fat reserves to survive the winter hibernating period) vibrations may force snakes above ground to find a more suitable refuge, where they may freeze to death or starve.

Shadow-flicker may interfere with visual identification of prey, or may directly alter the abundance of some prey species. An operating wind farm may also alter the abundance or efficiency of other species which prey upon the Coachwhip—raptors, mammals, and other snakes—with uncertain implications for the Coachwhip population.

Recommendation # 33: The Department recommends the County consider requiring the applicant to perform biological surveys sufficient to estimate the numbers of Coachwhip Snakes in the vicinity and identify their areas of activity. A radio-telemetry study of the movements of captured specimens, both before and after construction, would provide extremely useful data.

Recommendation #34: The Department recommends the County consider a requirement the applicant provide training to all workers employed on the project regarding the Coachwhip Snake and the procedures to be followed in response to sightings or encounters with this species.

Recommendation #35: The Department recommends the County consider a requirement the applicant retain qualified herpetologists to serve as snake monitors during construction, to be present at all times during construction, to patrol and observe internal roads and construction areas to prevent the injury or death of snakes, and having the authority to halt activities which threaten individual snakes.

Recommendation #36: The Department recommends an interior project speed limit of 15 miles per hour to reduce the chances of vehicle-caused mortality.

Recommendation #37: The Department recommends the County consider imposing a requirement for the applicant to seek an Incidental Take Authorization from the Department for the Coachwhip Snake.

Great Plains Rat Snake, *Pantherophis emoryi*. Not to be confused with its close relative, the **Gray Rat Snake**, *Pantherophis spiloides*, which also occurs in Monroe County, in Illinois the Great Plains Rat Snake reaches its northeastern limits in the Mississippi River counties north and south of St. Louis. An important differentiating mark is a spear-shape on top of its head, where lateral stripes come to a point, although in many specimens the lines do not completely meet. It may be limited to the vicinity of the bluffs along the River, being found both in the flood plains and in the hill prairies and forests above them.

Like other rat snakes, it is a good climber, spending much time in trees seeking birds, eggs, mice and squirrels, as well as significant time underground exploring mammal burrows. It prefers lightly forested grassy openings (hill prairies) and rock outcrops. It has a relatively low tolerance for heat and tends to be more active after dark than in daylight, when it often retreats underground or to shelter beneath logs and leaf-litter. Rodents are its primary prey. It is a non-venomous constrictor. Like another close relative, the **Corn Snake**, *Pantherophis guttatus*, it can sometimes be found in buildings, such as barns and sheds, where rodents are plentiful.

As with other apparently rare snakes in Illinois, many records are the result of road-kills found along the roads near the river bluffs.

As with the Coachwhip, the true extent of its distribution and its population numbers are poorly understood. In more central parts of its range it does not appear restricted to particular habitats. Even if its hibernation sites are along the bluffs, during the course of an activity season it may be able to travel significant distances.

Potential threats posed by a wind farm are the same or similar as those listed above for the Coachwhip, but lunar flicker is likely more important as a potential impact to this nocturnal species. Snakes in general rely on detecting vibrations in the ground through their belly scales to determine if predators are nearby and will actually move away from those vibrations to avoid detection. Since the Great Plains Rat Snakes are overwintering in the river bluffs of Monroe and Randolph counties, and need to remain dormant during hibernation (to conserve fat reserves to survive the winter hibernating period) turbine vibrations may force snakes above ground to find a more suitable refuge, where they may freeze to death or starve.

Recommendation # 38: The Department recommends the County consider requiring the applicant to perform biological surveys sufficient to estimate the numbers of Great Plains Rat Snakes in the vicinity and their areas of activity. A radio-telemetry study of the movements of captured specimens, both before and after construction, would provide extremely useful data.

Recommendation #39: The Department recommends the County consider a requirement the applicant provide training to all workers employed on the project regarding the Great Plains Rat Snake and the procedures to be followed in response to sightings or encounters with this species.

Recommendation #40: The Department recommends the County consider a requirement the applicant retain qualified herpetologists to serve as snake monitors during construction, to be present at all times during construction, to patrol and observe internal roads and construction areas to prevent the injury or death of snakes, and having the authority to halt activities which threaten individual snakes.

Recommendation #41: The Department recommends an interior project speed limit of 15 miles per hour to reduce the chances of vehicle-caused mortality.

Recommendation #42: The Department recommends the County consider imposing a requirement for the applicant to seek an Incidental Take Authorization from the Department for the Great Plains Rat Snake.

Flathead Snake, *Tantilla gracilis*. At first glance, this small snake is often mistaken for an earthworm. This animal is likely active on the surface only at night; daytime observations are the result of road-kills and searching beneath rocks, logs, and other debris in likely habitat.

This is yet another species apparently limited to the Mississippi River bluffs in Southern Illinois. The species is widespread from Missouri to Texas.

This very small snake feeds on invertebrates, snails, scorpions, and earthworms. Due to its size it has a wide array of predators. Little is known of its sensitivity to environmental disturbances. It is abundant in much of its range, but its numbers and extent in Illinois are poorly understood. Unlike many other snakes in the region, it is not thought to aggregate in large groups for hibernation and mating, remaining solitary for much of its life.

Depending on its actual distribution, the major impact to this species may be the result of ground vibrations, if such vibrations alter the behavior of the Flathead Snake, its prey, or its predators, or alter the physical attributes of its habitat. Numerous dead specimens have been collected from the Bluff Road south of Valmeyer, so wind farm construction traffic should avoid this route. It is possible, however, this species also occupies some interior wooded glades.

Recommendation # 43: The Department recommends the County consider requiring the applicant to perform biological surveys sufficient to estimate the numbers of Flathead Snakes in the vicinity and their areas of activity. A radio-telemetry study of the movements of captured specimens is impractical due to the small size of this animal.

Recommendation #44: The Department recommends the County consider a requirement the applicant provide training to all workers employed on the project regarding the Flathead Snake and the procedures to be followed in response to sightings or encounters with this species.

Recommendation #45: The Department recommends the County consider a requirement the applicant retain qualified herpetologists to serve as snake monitors during construction, to be present at all times during construction, to patrol and observe internal roads and construction areas to prevent the injury or death of snakes, and having the authority to halt activities which threaten individual snakes.

Recommendation #46: The Department recommends an interior project speed limit of 15 miles per hour to reduce the chances of vehicle-caused mortality.

Recommendation #47: The Department recommends the County consider restricting wind farm construction traffic to Route 156, avoiding Bluff Road.

Recommendation #48: The Department recommends the County consider imposing a requirement for the applicant to seek an Incidental Take Authorization from the Department for the Flathead Snake.

Timber Rattlesnake, *Crotalus horridus*. This pit viper has been the object of relentless persecution by humans since the days of the first European settlements in the region. Though its bite is serious and can be fatal, this animal will escape confrontation if possible. Most bites are the result of human harassment or occur as the result of inadvertent encounters.

The species needs little introduction in areas where it occurs. The Timber Rattler is extremely well-camouflaged in its natural environment and difficult to spot when at rest. It is an ambush predator which feeds primarily on small rodents, positioning itself near runways and waiting for its next meal to approach.

Like other cold-blooded animals, basking is important to thermo-regulation; rocky outcrops and sunny open spaces, such as trails and roads, are useful for this purpose. Consequently, many Department records for this species are road-kills.

Because of its fearsome reputation, much more is known about the ecology of the Timber Rattlesnake than that of other snakes. Of central importance to its conservation is the protection of dens, subterranean locations where Rattlesnakes congregate and spend the winter. Females seldom roam more than a mile from the den, but males will range farther, perhaps out to two miles. Snakes follow their own scent trails back to the den at the end of the active season. The loss or destruction of a den site virtually assures the extirpation of the population which uses it, since other suitable sites are not easily found. Female Rattlesnakes reproduce only every other year, or perhaps every third year, and may be lucky to have two reproductive opportunities in their lifetimes. Hence, the loss of a single female is a serious threat to a local population.

A number of den sites are known to the Department along the bluffs north and south of Valmeyer, and others are suspected in the area. This suggests a large portion of the wind energy

project area lies within two miles of a den site or multiple dens. However, the Department is at present unable to estimate the population of Timber Rattlesnakes which may be present.

Rattlesnakes routinely hunt and bask in agricultural fields, as well as in the woodlands. The proliferation of service roads will invite basking behavior which may subject individual snakes to greater risk of injury from maintenance vehicles (and their occupants).

But apart from road-kill or persecution, Rattlesnakes may be subject to acoustic harassment from the operation of multiple wind turbines. Though Rattlesnakes do not have well-developed ear structures, vibrations are transmitted through their belly scales to their skeletons and directly to their auditory nerves. Consequently, for these animals, ground vibrations should be equated with noise. Constant and elevated noise levels may have both positive and negative effects. For example, prey may be more abundant because it will be easier for prey animals to avoid other predators which compete with the snakes.

Their primary prey consists of rodents; factors which affect rodent populations will affect the snakes. Some studies have documented that rodent populations expand in areas with constant anthropogenic noise, because some rodent predators, particularly raptors and owls which hunt primarily by sound, have trouble pinpointing their targets.[6] If wind turbine noise hampers raptors, it may increase rodent populations, increasing the prey base for Rattlesnakes and other snakes. Rattlesnakes may be less affected by sound than are other predators, since they locate prey both by movement and thermal infrared sensing. This would be a positive outcome for the snakes, unless some other aspect of wind turbine operations hampers reptilian hunting. However, stress from acoustic stimulation may impair the snakes' urge to feed, with the result that individuals may not acquire sufficient fat reserves to survive until spring, even when prey is to be easily obtained.

Snakes may also be less able to detect and avoid their own predators. Rattlesnakes use vibrations to determine if predators are nearby and will actually move away from those vibrations to avoid detection. Wind turbine vibrations may mask predator movements, or simulate them. Vibrations might be sufficient in the winter to force snakes above-ground to escape perceived predators, where they would then be subject to actual predation, in addition to freezing injury or mortality. Snakes would tend to move away in a straight line from the source of vibration until a threat was no longer perceived, but the presence of multiple turbines would render this maneuver much more difficult. Even if they do not exit the den, acoustic disturbance may cause frequent arousal, resulting in energy losses which cannot be replaced.

It is possible that shadow-flicker may alter rodent behavior, with resulting indirect effects to the snakes. Rodents which are not moving may be less susceptible to being eaten, while the shadow-flicker may stimulate defensive responses from the snakes, as well, since they, too, are vulnerable to raptors, and shadow-flicker may simulate their approach or presence.

[6] Francis, et al.; Noise Pollution Alters Ecological Services: Enhanced Pollination and Disrupted Seed Dispersal; Proceedings of the Royal Society B: Biological Sciences; March 21, 2012.

Although the Rattlesnakes in Texas and California are not Timber Rattlesnakes, the Department is unaware of any efforts to research the effects of wind turbines where both turbines and Rattlesnakes are abundant.

Recommendation # 49: The Department recommends the County consider requiring the applicant to perform biological surveys sufficient to estimate the numbers of Timber Rattlesnakes in the vicinity and their areas of activity. A radio-telemetry study of the movements of captured specimens would greatly improve understanding of this species' use of the local environment.

Recommendation #50: The Department recommends the County consider restricting wind farm construction traffic to Route 156, avoiding Bluff Road. Because several Rattlesnakes have been killed on Route 156 in the vicinity of Valmeyer, the County should also consider posting "Snake Crossing" signs in the vicinity of the Village.

Recommendation #51: The Department recommends the County consider a requirement the applicant retain qualified herpetologists to serve as snake monitors during construction, to be present at all times during construction, to patrol and observe internal roads and construction areas to prevent the injury or death of snakes, and having the authority to halt activities which threaten individual snakes.

Recommendation #52: The Department recommends an interior project speed limit of 15 miles per hour to reduce the chances of vehicle-caused mortality.

Recommendation #53: The Department recommends the County consider imposing a requirement for pre- and post-construction monitoring of ground vibration levels at identified den sites, coupled with reports of snake responses, if any.

Recommendation #54: The Department recommends the County consider a requirement the applicant provide training to all workers employed on the project regarding the Timber Rattlesnake and the procedures to be followed in response to sightings or encounters with this species.

Recommendation #55: The Department recommends the County consider imposing a requirement for the applicant to seek an Incidental Take Authorization from the Department for the Timber Rattlesnake.

Loggerhead Shrike, *Lanius ludovicianus*. The Loggerhead Shrike, whose listing status was elevated from "threatened" to "endangered" in 2009, occurs in Monroe County as both a migrant and a resident breeder. No estimate of migrant numbers passing through Monroe County is available.

Recorded locations of Shrike nests exist on all sides of the proposed project area, and it is likely that suitable habitat exists within it. Though often classified as a grassland bird, savanna-like conditions provide better habitat, but the Shrike must often be satisfied with solitary trees or shrubs and field edges.

The Shrike nests in trees or shrubs in proximity to scrub or pasture land where larger insects and small rodents are abundant. Trees and shrubs with stout thorns provide Shrikes an opportunity to temporarily store prey, by impalement, until it decomposes enough to be easily dismembered and eaten. Shrike populations have declined with the destruction of hedge-rows and wind breaks along field edges to promote greater agricultural productivity, forcing shrikes to make use of woodland edges, road-sides, and, occasionally, human homesteads.

Shrikes have been recorded as wind turbine collision casualties in Wyoming, but have not been recorded as mortalities in eastern states. It is unclear whether the western losses occurred during migration or residential foraging. The clearing of trees and shrubs during the nesting season may offer more risk of loss than turbine collisions, due to the destruction of unidentified nests, but the potential effects of noise and shadow-flicker have not been assessed.

Standard breeding bird surveys commissioned by the applicant have not identified the Loggerhead Shrike as breeding within the project footprint at the time of the survey. However, given the longevity of a wind farm project, the absence of nesting pairs at one point in time is not conclusive proof that Shrikes will never use the area in the future. Ample suitable habitat exists in the vicinity.

Recommendation #56: The Department recommends the County consider a requirement for post-construction avian mortality monitoring to identify potential mortality of the Loggerhead Shrike.

Recommendation #57: The Department recommends the County consider a requirement for periodic breeding bird surveys, perhaps every five years, of areas within one mile of project wind turbines to identify and document Shrike breeding behavior in the vicinity.

Recommendation #58: The Department recommends the County consider a requirement the applicant provide training to all workers employed on the project regarding the Loggerhead Shrike and the procedures to be followed in response to sightings or encounters with this species.

Recommendation #59: The Department recommends the County consider imposing a requirement for the applicant to seek an Incidental Take Authorization from the Department for the Loggerhead Shrike.

Mississippi Kite, *Ictinia mississippiensis*. The state-listed threatened Mississippi Kite occurs in Monroe County as both a migrant and a summer breeding resident. A predator of dragonflies, grasshoppers, other large insects, and small rodents, in Monroe County a large number of Kites nest in the River bottomlands where preferred prey is plentiful. However, the large number of flooded sinkholes in the karst plain also provide potential habitat. Breeding bird surveys commissioned by the applicant did not identify breeding Kites within the project footprint. But no estimate of migrant Kites is available, and it may be that the risk of collision for migrants is greater than the risk of taking or disturbing local nesters.

Recommendation #60: The Department recommends the County consider a requirement for post-construction avian mortality monitoring to identify potential mortality of the Mississippi Kite.

Recommendation #61: The Department recommends the County consider a requirement for periodic breeding bird surveys, perhaps every five years, of areas within one mile of project wind turbines to identify and document Mississippi Kite breeding behavior in the vicinity.

Recommendation #62: The Department recommends the County consider a requirement the applicant provide training to all workers employed on the project regarding the Mississippi Kite and the procedures to be followed in response to sightings or encounters with this species.

Recommendation #63: The Department recommends the County consider imposing a requirement for the applicant to seek an Incidental Take Authorization from the Department for the Mississippi Kite.

Black-Billed Cuckoo, *Coccyzus erythropthalmus*. This threatened Cuckoo is also present in Monroe County as both a migrant and a resident breeder. It is likely the numbers of migrants significantly exceeds those of local breeders. Black-Billed Cuckoos prefer forest edges and thickets as nesting sites, and such habitat is abundant in the vicinity of the proposed project area. Caterpillars and large insects are preferred prey. Breeding bird surveys commissioned by the applicant did not identify breeding Cuckoos within the project footprint.

This species is often tallied beneath communications towers and tall buildings as a collision casualty. A Black-Billed Cuckoo was killed by a wind turbine in Henry County, Illinois, in July 2012. Turbines are believed more likely to pose a threat to migrants than to local breeders, which may seldom have cause to rise to altitudes within the rotor sweep of utility-scale machines. Whether or to what degree noise, motion, or shadow-flicker may affect Cuckoo behavior has not been evaluated.

Recommendation #64: The Department recommends the County consider a requirement for post-construction avian mortality monitoring to identify potential mortality of the Black-Billed Cuckoo.

Recommendation #65: The Department recommends the County consider a requirement for periodic breeding bird surveys, perhaps every five years, of areas within one mile of project wind turbines to identify and document Black-Billed Cuckoo breeding behavior in the vicinity.

Recommendation #66: The Department recommends the County consider a requirement the applicant provide training to all workers employed on the project regarding the Black-Billed Cuckoo and the procedures to be followed in response to sightings or encounters with this species.

Recommendation #67: The Department recommends the County consider imposing a requirement for the applicant to seek an Incidental Take Authorization from the Department for the Black-Billed Cuckoo.

Cerulean Warbler, *Dendroica cerulea*. Migrant members of this threatened species transiting Monroe County probably outnumber nesting pairs in the area. This species dwells in interior forest blocks, but this habitat is well-represented along the bluffs of the River valley (more than 1,500 acres) and suitably large blocks exist on the karst plateau.

Migrating warblers, as a class, comprise the majority of avian casualties at Midwestern wind farms. The summer breeding range of the Cerulean Warbler includes all of Illinois, and nesting records occur in Monroe County. (The Cerulean Warbler was documented in Salt Lick Point Land & Water Reserve during the 2011 "bio-blitz and in the White Rock LWR in 2012.) Turbines are not thought to pose a collision risk to resident Cerulean Warblers, which will spend most of their time foraging in the forest canopy. The most plausible impact, other than migrant collisions, may be related to turbine noise, which may be great enough to interfere with communications among individuals or enough to restrict access to otherwise suitable nesting sites in already limited essential habitat.

Recommendation #68: The Department recommends the County consider a requirement for post-construction avian mortality monitoring to identify potential mortality of the Cerulean Warbler.

Recommendation #69: The Department recommends the County consider a requirement the applicant provide training to all workers employed on the project regarding the Cerulean Warbler and the procedures to be followed in response to sightings or encounters with this species.

Recommendation #70: The Department recommends the County consider a requirement for periodic breeding bird surveys, perhaps every five years, of areas within one mile of project wind turbines to identify and document Cerulean Warbler breeding behavior in the vicinity.

Recommendation #71: The Department recommends the County consider imposing a requirement for the applicant to seek an Incidental Take Authorization from the Department for the Cerulean Warbler.

State-listed Endangered or Threatened Plants. The *Illinois Endangered Species Protection Act* [520 ILCS 10/3] prohibits the taking of any listed plant without the expressed written permission of the land owner. Harming a listed plant "in any manner" is a criminal offense. Apart from completely avoiding a listed plant and its essential habitat, the only means of avoiding such liability is obtaining the owner's written permission; the Department may not grant permission over the owner's objection.

Two courses of action suggest themselves: performing thorough botanical surveys to identify and locate listed plants so precautions can be taken to avoid harming them, or obtaining the written permission of land owners to take such plants which may be present. The Department prefers the performance of botanical surveys and the implementation of protective measures.

These state-listed plants are known to be present or may be present in the vicinity of the project area or within the project area: the endangered **Crested Coralroot Orchid**, *Hexalectris spicata*; the **Dwarf Bedstraw**, *Galium virgatum*; the **Fameflower**, *Talinum calycinum*; the **Shortleaf Pine**, *Pinus echinata*; the **Slender Heliotrope**, *Heliotropium tenellum*; the **Spurge,** *Euphorbia spathulata*; **Whitlow Grass**, *Draba cuneifolia*; **Black-Edged Sedge**, *Carex nigromarginata*; and the **Woolly Buckthorn,** *Bumelia lanuginosa*; and the threatened **Missouri Orange Coneflower**, *Rudbeckia missouriensis*.

Most of the known locations of occurrences lie within the boundaries of dedicated Nature Preserves, registered Land & Water Reserves, designated Natural Heritage Landmarks, and Illinois Natural Areas Inventory (INAI) Sites in the vicinity of the proposed wind farm. Such areas tend to have received much more thorough scientific investigation over the years than similar areas with suitable habitat. Consequently, it is quite possible that unidentified colonies of these or other species of listed plants exist on or near lands which will be directly or indirectly affected by wind farm construction and operation.

Obviously plants can be injured directly, but they can also be adversely affected by changes in local hydrology, by soil compaction, by changes in canopy cover, and by changes in the behavior of animals which play roles in pollination, herbivory, parasite control, seed dispersal, soil aeration, nutrient release and the propagation of symbiotic mycorrhizal fungi. Such impacts are more subtle and indirect but nonetheless important in conserving rare plant species.

Recommendation #72: The Department recommends the County consider imposing a requirement for the applicant to perform botanical surveys of leased lands for the presence of State-listed endangered or threatened plants.

Recommendation #73: The Department recommends the County consider a requirement the applicant provide training to all workers employed on the project regarding the State-listed plants in the area and the procedures to be followed in response to observations of them or similar species.

Recommendation #74: The Department recommends the County consider imposing a requirement for the applicant to obtain written permission to take listed plants from lessors if botanical surveys are not performed.

Recommendation #75: The Department recommends the County consider imposing a requirement for the applicant to avoid direct disturbance of listed plant species where feasible.

Recommendation #76: The Department recommends the County consider imposing a requirement for the applicant to conserve, to the extent possible, the genetic materials of listed plants authorized to be taken. This might consist of attempted translocation of plants to suitable habitat on-site or elsewhere, or the collection of seeds, rhizomes, or tubers for use in natural area restoration efforts on-site or elsewhere.

Salt Lick Point Land and Water Reserve; Columbia Hill Prairie Illinois Natural Areas Inventory (INAI) Site. The Salt Lick Point Land & Water Reserve (LWR) is contained within the Columbia Hill Prairie INAI Site; a few acres of the INAI Site lie outside the LWR but, for practical purposes, they are nearly synonymous. Due to the higher level of legal protection provided by registration as a Land & Water Reserve, this discussion will treat the two entities as one and the same.

Salt Lick Point LWR contains bluff-top forests, deeply-incised ravines, and hill prairies, north of State Rt. 156 and northeast of the original Village of Valmeyer. No part of Salt Lick Point lies within the proposed project area, but significant portions of the project area lie within one mile of the LWR.

Salt Lick Point protects high-quality Loess Hill Prairie and Limestone Glade natural communities with high biological diversity. A 2011 "bio-blitz" catalogued over 1,000 species of plants and animals within the LWR, including the state-listed **Cerulean Warbler, Timber Rattlesnake, Flathead Snake,** and **Great Plains Rat Snake**. The Tri-Color Bat and the Big Brown Bat, two species subject to wind turbine collision mortality, were also tallied. Apart from those species in permanent residence, the Reserve provides important stop-over habitat for migratory birds. Anything which influences the composition of the animal communities has the potential to alter the plant associations within the LWR. Such changes are far more likely to be detrimental than beneficial.

Salt Lick Point LWR will not be directly disturbed by construction activities within its boundaries, but it is likely to be adversely modified by effects related to construction of the project and its subsequent operations. These include blasting effects should that be necessary for wind turbine foundation construction, noise and vibrations generated by turbine operation, visible motion, and shadow flicker.

One benefit provided by protected Natural Areas is their ability to provide glimpses of pre-settlement North America. Due to its topography, the Salt Lick LWR offers many locations where it is possible to envision pre-settlement conditions; only along its margins are the works of modern civilization evident. However, multiple utility-scale wind turbines in the proposed project area may be visible from many of the ridge-tops and hill prairies within the Reserve, diminishing this wilderness impression. Turbines at a greater distance will be less likely to impair this visualization value.

Turbines located to the southeast within a mile of the Reserve may be capable of casting flicker shadows into the forest canopy during the morning in the fall, winter, and spring. While many sensitive animal species will be hibernating during this period, flicker into the canopy may adversely affect birds seeking shelter there. In the spring, hill prairies and rock outcrops within the shadow arc, normally used as basking areas by snakes and other reptiles, may no longer offer this key opportunity due to the periodic shadows. Passing shadows may stress other forms of wildlife, diminishing the habitat value of the affected areas. Salt Lick is unlikely to lie within the shadow arc of wind turbines during the summer period between equinoxes.

Should blasting be needed to construct turbine foundations on or within bedrock, the resulting vibrations could have adverse effects within the LWR. (When the nearby quarry was active, underground blasting occurred routinely, but Columbia Hill Prairie INAI Site was not then a registered Land & Water Reserve, as it is today, and so not as strongly protected.) While potential vibrations may not be sufficient to destroy existing dens and hibernaculae, they could be damaged, and the animals which use them would suffer harassment. Using smaller explosive charges and siting turbines as far as possible from Reserve boundaries would lessen—but perhaps not eliminate—such effects.

As demonstrated by studies in Scotland, normally-operating wind turbines produce vibrations which propagate up to six miles through bedrock.[7] Though not strong, constant vibrations from multiple sources may interfere with the normal sensory experiences of many species which spend significant time on or below the ground, prompting responses which are difficult to predict. Increasing the distance between the source of vibration and habitats within the Reserve may be the best way to minimize or avoid such effects.

Anthropogenic sources of noise are well-documented to affect animal behavior.[8] Utility-scale wind turbines produce noise from several sources: pitch-control motors and yaw-control motors, as well as the generators and blades. While many turbine manufacturers assert their machinery is quieter than 40 decibels at 1,000 feet, this may still be more than sufficient to affect animals within some portions of the Reserve, which may be sensitive to frequencies above or below the range of human hearing. It cannot be assumed sounds tolerated by humans can be tolerated by wildlife.

Again, increasing the distance from sound sources offers the best opportunity to reduce potential adverse effects. Salt Lick Point is already bounded by numerous potential sources of anthropogenic noise—industrial locations, highways, and residential neighborhoods—and these no doubt have their effects, but wind turbine noise will be nearly constant and will contain frequencies which may not be components of other noises, which tend to be intermittent. The differences and the cumulative effects could be significant.

Multiple-turbine wind farms create issues of intermittent illumination after dark due to the requirement for aviation safety lighting. Safety lights are typically synchronized across a wind farm, flashing simultaneously. These red lights can be seen for many miles, but at closer ranges can provide significant illumination of objects on the ground. Animals adapted to nocturnal behavior have good vision in low-light conditions. Red light does not impair night vision when the lights go off, but they may provide enough extra illumination to negate the advantages of natural camouflage, robbing animals of concealment from predators. The Federal Aviation Administration has recently approved some Audio-Visual Warning Systems which operate safety lighting only when an aircraft is approaching on a collision vector, which alleviates most adverse effects of night lighting.

Recommendation #77: The Department recommends the County consider a requirement for a set-back from the Salt Lick Point Land & Water Reserve of at least one mile. This may affect

[7] Ibid; Styles, et al.
[8] Ibid; Francis, et al.

only those wind turbines planned for the northwest sector of the wind farm. This will minimize or reduce the adverse effects of visibility, noise, vibration, and illumination.

Recommendation #78: The Department recommends the County consider a prohibition on the use of explosives during wind farm construction.

Recommendation #79: The Department recommends the County consider a requirement to deploy an Audio-Visual Warning System to alleviate routine intermittent aviation lighting of the Land & Water Reserve.

White Rock Land & Water Reserve; Martha and Michelle Prairies Land & Water Reserve; Luella Schaefer Memorial Land & Water Reserve; Snakey Acres Natural Heritage Landmark; Potato Hill Natural Heritage Landmark; and Potato Hill Prairie INAI Site. A complex of individually-registered Land & Water Reserves and designated Natural Heritage Landmarks are contained within the encompassing Potato Hill Prairie INAI Site. This area extends nearly 1.5 miles south from State Route 156, between Bluff Road and the karst plateau, southeast of Old Valmeyer.

The Potato Hill Prairie INAI Site is similar in its biodiversity and ecological functions to Salt Lick Point, but in some respects may be ecologically more important in that it has records for the state-listed **Coachwhip Snake** and **Common Striped Scorpion**, as well as all species found at Salt Lick Point, and its forests are documented as being used by both the **Indiana Bat** (mist-netting) and the **Gray Bat** (acoustic recording). Because these parcels have not received the level of scientific scrutiny applied to Salt Lick Point, the ecological value of these areas is probably under-appreciated.

Another important difference is that wind turbines may be sited directly east of this INAI Site, where their access roads and construction sites will be accessible to those listed animals which may travel beyond the forest edges. As a result, all of the adverse effects described above—flicker, noise, vibration, and illumination—will be more severe and their consequences magnified. For example, the forest canopies of these parcels will be subject to shadow flicker for many more hours per year, including the all-important spring and fall migratory periods.

In addition, the White Rock LWR is open to the public. The sight, sound, and flicker associated with the wind farm as currently configured will diminish the recreational experience of Reserve visitors.

Recommendation #80: The Department recommends the County consider a requirement for a set-back from the registered Land & Water Reserves of at least one mile. This will at least reduce, though perhaps not minimize, the adverse effects of visibility, noise, vibration, and illumination. Setbacks from the INAI boundaries should be at least one-half mile.

Recommendation #81: The Department recommends the County consider a prohibition on the use of explosives during wind farm construction.

Recommendation #82: The Department recommends the County consider a requirement to deploy an Audio-Visual Warning System to alleviate routine intermittent aviation lighting of the Land & Water Reserves.

Recommendation #83: The Department recommends the County consider a requirement for the applicant to perform additional pre-construction mist-netting and telemetry bat studies within Potato Hill Prairie INAI Site in an effort to identify the locations of maternity colonies and underground night roosts for the Indiana Bat and Gray Bat, respectively.

Frog Karst System INAI Site; **Pautler-Annbriar Karst System INAI Site**; **Madonnaville Cave INAI Site**; **Pautler Class 3 Ground Water Area**. These three cave systems underlie the majority of the eastern and southern portions of the proposed project area. Extensive dye-tracing and geologic studies have allowed the Illinois Environmental Protection Agency (IEPA) to designate much of their common area as the Pautler Class 3 (Special Resource) Ground Water Area. These cave systems raise three major issues related to wind energy development.

This karst region may not offer sufficient geological stability to support a wind farm. Major damage to the wind farm's infrastructure or major damage to the underlying cave systems are possibilities. Along with its mandatory foundation system, each wind turbine weighs approximately 500 tons. Foundations typically penetrate the ground up to twelve feet. In this region, there may be areas where unconsolidated soils may not reach this depth. Even where they do, the underlying limestone may be thin or honeycombed with voids. Nor will the loading from each turbine remain static. With changing wind direction and force, dynamic stresses which did not exist before will be transmitted to the ground, where they may introduce or accelerate damage to the supporting rock formations. The potential for sudden subsidence cannot be ignored.

Geologic instability poses risks to both the economic viability of the wind farm and the geological integrity of the underlying cave systems. If built, this wind farm would be the first in Illinois, perhaps in the nation, to be constructed on karst geology.

A Class III Ground Water designation imposes accountability for the pollution or diminution of a ground water resource. [See the *Illinois Ground Water Protection Act*, 415 ILCS 55, and IEPA Administrative Rules, *Title 35, Part 620*.] In this case, the Class III Ground Water supports ecologically-unique subterranean natural systems, including essential habitat for the **Illinois Cave Amphipod**. Parties or persons who impair such a ground water in terms of its special resource use can face penalties for doing so. If built, this wind farm would be the first in Illinois constructed within a Class III Ground Water recharge area; consequently, there are no precedents.

Last, but not least, each of these cave systems provides essential habitat for the endangered **Illinois Cave Amphipod** and, in the case of the Madonnaville Cave, for the endangered **Madonna Cave Springtail**, as well. Because these systems are unique, adverse modifications could have serious implications for the continued survival of these species, including the potential for extinction.

Construction above these cave systems has the potential to alter surface and subsurface drainage, altering the points where recharge occurs and changing the volumes of water entering various points. Blasting certainly has the potential to damage nearby voids or to alter water quality. Vibrations associated with turbine operation may have more gradual but no less significant effects. Any sudden collapse or the creation of new openings would alter temperatures and humidity levels within the cave systems, with potential serious consequences for the cave fauna.

Recommendation #83: The Department recommends the County consider prohibiting construction of utility-scale wind turbines above known cave systems and consider an appropriate setback from delineated Class III Ground Waters.

Recommendation #84: The Department recommends the County consider a requirement for detailed mapping of subterranean voids and passages prior to authorizing any construction related to the proposed wind farm. However, the applicant should be aware that even advanced technologies appropriate for use in such mapping may have potential adverse effects on the Illinois Cave Amphipod which would require specific authorization from the Department of Natural Resources and the U.S. Fish & Wildlife Service.

Recommendation #85: The Department recommends the County consider a prohibition of blasting for the purpose of establishing adequate foundations.

Recommendation #86: The Department recommends the County consider a requirement the applicant minimize any alteration of surface or subsurface hydrology by carefully mapping pre-construction surface drainage and adopting measures to assure that the path and flow rates of such drainage are maintained during and after construction, including expeditious repair or replacement of any drain tiles which may be present.

Recommendation #87: The Department recommends the County consider a requirement the applicant provide training to all workers employed on the project describing the sensitivity of the karst systems and the importance of careful management of fuels, lubricants, portable toilets, and other potential ground water pollutants.

Consultation on the part of the Department is terminated, unless Monroe County desires additional information or advice related to this proposal. In accordance with 17 Ill. Adm. Code 1075.40(h), the County must notify the Department of its decision regarding these recommendations, whether it will:

- Proceed with the action as originally proposed;
- Require the action to be modified per Department recommendations (please specify which measures if not all will be required); or
- Forgo the action.

This consultation is valid for two years unless new information becomes available which was not previously considered; or the proposed action is modified; or additional species, essential habitats, or Natural Areas are identified in the vicinity. If the project has not been implemented

within two years of the date of this letter, or any of the above listed conditions develop, a new consultation is necessary.

The natural resource review reflects the information existing in the Illinois Natural Heritage Database at the time of the project submittal, and should not be regarded as a final statement on the site being considered, nor should it be a substitute for detailed site surveys or field surveys required for environmental assessments.

If additional protected resources are encountered during the project's implementation, the applicant must comply with the applicable statutes and regulations. Also, note that termination does not imply IDNR's authorization or endorsement of the proposed action. Please contact me if you have questions regarding this review.

Sincerely,

Keith M. Shank
Impact Assessment Section
Division of Ecosystems and Environment
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(217) 785-5500

cc: Jenny Skufca, Illinois Nature Preserves Commission
Jim Valleroy, Terracon Inc.